A shift in phytoplankton dominance from cyanobacteria to chlorophytes following algaecide applications

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Introduction

Cyanobacteria can form massive blooms in nutrient enriched environments. Some species are capable of producing hepatotoxins that are harmful to both humans and animals following ingestion. Chemical algaecides are frequently used to control these blooms in order to minimize their impact to both humans and wildlife. In this study, we compared copper sulfate with sodium carbonate peroxyhdrate (PAK-27^{TM}) on natural cyanobacterial populations. Studies have shown that copper does not readily dissipate from the environment and can thus accumulate over time to levels considered lethal to other organisms - especially invertebrates and fishes. PAK-27^{TM} was developed to be an environmentally friendly algaecide that specifically targets cyanobacteria and decomposes within several weeks into water and oxygen. For this study, three levels of algaecide (0.15, 1.5, and 5.0 ppm; either copper sulfate or PAK-27^{TM}) were used to treat a cyanobacterial bloom (dominated by *Anabaena circinalis*, *Microcystis aeruginosa*, and *Planktolyngbya limnetica)* cultured in 4L microcosms. The treatments were monitored over time, to evaluate changes in species abundance and composition.

Hypotheses

Both algaecides would be effective in controlling algal blooms. There would be treatment (algaecide) level-specific community responses due to chemical applications, with most of the changes in phytoplankton community composition occurring at lower levels.

Methods

A total of 65 microcosms (4L cubitainers) were used during this investigation. Chemical treatments were implemented during a bloom period at peak densities, and consisted of three dose levels of sodium carbonate peroxyhdrate or copper sulfate (0.15 ppm, 1.5 ppm, and 5.0 ppm; n=10). Population densities were monitored on Day-1, Day-5, and Day-15. Plankton counts were performed using a Sedgwick-Rafter counting cell according to APHA methods. During incubation, all microcosms were situated within the lake proper to insure natural temperature and light regimes.

Results & Conclusion

The experiment involved microcosms inoculated with pond water (late September - October) that was experiencing a cyanobacterial bloom comprised primarily of *Anabaena circinalis* (up to 6,000 units mL^{-1}), *Microcystis aeruginosa* (100 units mL^{-1}), and *Planktolyngbya limnetica* (200 units mL^{-1}). Copper treatments were more effective than PAK-27^{TM} on all three cyanobacterial species by Day-15, as illustrated by a two-fold decrease in *A. circinalis*, and greater than a 10-fold decrease in both *M. aeruginosa*, and *P. limnetica*. In contrast, no significant declines were observed in microcosms treated with PAK-27^{TM}. One of the more interesting findings from this study was the dominance of green algae following chemical removal of cyanobacteria. In this case, for low and moderate copper, the removal of cyanobacteria resulted in significant increases in *Staurastrum sp.* (up to 500 units mL^{-1}), *Eudorina elegans* (up to 7,000 units mL^{-1}), and *Scenedesmus sp*. (up to 6,000 units mL^{-1}). This shift in community composition, from cyanobacteria to green algae following chemical treatments, may indicate a competitive exclusion of green algae by cyanobacteria. Moreover, this response indicates that cyanobacteria are less tolerant to copper relative to green algae. Nevertheless, high copper levels (at 5 ppm) resulted in substantial declines in all algal taxonomic groups.